

Preliminary Amendment
Application No.: 10/820,025
Reply to Office Action dated November 16, 2007
July 15, 2008

REMARKS

By this amendment, claims 6, 8, 11 and 13 have been cancelled, claims 7, 9, 12 and 14 have been amended and new claims 20-22 have been added in the application. Currently, claims 3-5, 7, 9, 10, 12, 14-15 and 20-22 are pending in the application.

Claim 6 was objected to as being of improper dependent form. By this amendment, claim 6 has been cancelled and dependent claim 7, which depended from claim 6, has been amended to depend from claim 5. Therefore, it is respectfully submitted that this objection has been overcome and should be withdrawn. Claims 8, 11 and 13 have also been cancelled and claims 9, 12 and 14 have been amended for similar reasons.

Claims 3-15 were rejected under 35 USC 103(a) as being obvious over Kawakami et al. (JP 1-242782). Also, claims 3-15 were rejected under 35 USC 103(a) as being obvious over Kawakami et al. in view of Weber et al. (U.S. Patent No. 6,274,241). Further, Claims 3-15 were rejected under 35 USC 103(a) as being obvious over Kawakami et al./Kawakami et al. in view of Weber et al./, further in view of Segawa et al. (JP 2001-316834).

These rejections are respectfully traversed in view of the enclosed Declaration under 37 CFR 1.132 showing the differences

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with the prior art to Kawakami et al. and Weber et al. and the remarks below.

The present invention relates to a conductive electroless plated powder and a method for making the same. More particularly, the present invention relates to a conductive electroless plated powder including core particles and a nickel film provided on each core particle, the nickel film having improved adhesion with the core particle (see page 1, lines 8-13 of the specification).

In the nickel film formed on the surface of the core particle, crystal grain boundaries are not recognized in the cross section in the direction of the thickness of the nickel film, i.e., perpendicularly to the surface of the core particle as shown in Fig. 1 (see page 5, lines 11-15 of the specification).

In the nickel film in which crystal grain boundaries are not recognized as shown in Fig. 1, unexpected results have been found which include that the adhesion between the nickel film and the surface of the core particle is remarkably high. The film becomes dense and homogeneous, resulting in an increase in adhesion between the nickel film and the surface of the core particle (see page 6, lines 1-9 of the specification).

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The method for making the plated powder mainly includes a catalyzation step (1), an initial thin film formation step (2), and an electroless plating step (3). In the catalyzation step, the core particles which have a noble metal ion-capturing ability or to which a noble metal ion-capturing ability is imparted by surface treatment are allowed to capture noble metal ions, and then the noble metal ions are reduced so that the surfaces of the core particles support the noble metal. In the initial thin film formation step (2), the core particles supporting the noble metal are dispersed in an initial thin film-forming solution containing nickel ions, a reducing agent, and complexing agent composed of an organic carboxylic acid or a salt thereof so that nickel ions are reduced to form initial thin nickel film on the surfaces of the core particles. In the electroless plating step (3), a nickel ion-containing solution containing the complexing agent and a reducing agent-containing solution are individually and simultaneously added to an aqueous suspension containing the core particles provided with the nickel initial thin film and the complexing agent to carry out electroless plating (see page 10, line 13 - page 11, line 10 of the specification).

Independent claim 3 recites the steps of "(II) dispersing the core particles in an aqueous medium comprising an initial thin-film-

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forming solution containing nickel ions, a reducing agent, and a complexing agent comprising an organic carboxylic acid or a salt thereof to prepare an aqueous suspension, and reducing the nickel ions to form a nickel initial thin film on the surface of the core particles; and (III) adding a first solution, which contains a nickel ion-containing solution and the complexing agent, and a second solution, which contains a reducing agent-containing solution, to the aqueous suspension individually and simultaneously, the aqueous suspension containing the core particles having the initial thin film on the surface thereof so as to perform electroless plating and so that grainless boundaries are recognized in cross section in a direction of a thickness of the nickel film" (emphasis added).

These features are not shown or suggested by Kawakami et al. Weber et al. and Segawa et al. or any combination of these references.

Kawakami et al. relate to an electroless plated powder and a production process therefore (see page 1, lines 14-15 of the translation).

Kawakami et al. disclose the step of allowing a core material to trap noble metal ions, and then reducing the ions to carry the metal on the surface of the core material (see page 14, lines 19-24 and page 15, lines 5-7 of the translation).

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Kawakami et al. also disclose the step of dispersing the powder of the core material in an aqueous suspension (page 16, line 11 - page 17, line 10 of the translation).

Kawakami et al. also disclose the step of adding at least two solutions constituting the electroless plating solution individually and simultaneously to the aqueous suspension to perform an electroless plating (see page 18, line 23 - page 19, line 6 of the translation).

Kawakami et al. do not disclose the steps of (II) dispersing the core particles in an aqueous medium comprising an initial thin-film-forming solution containing nickel ions, a reducing agent, and a complexing agent comprising an organic carboxylic acid or a salt thereof to prepare an aqueous suspension, and reducing the nickel ions to form a nickel initial thin film on the surface of the core particles; and (III) adding a first solution, which contains a nickel ion-containing solution and the complexing agent, and a second solution, which contains a reducing agent-containing solution, to the aqueous suspension individually and simultaneously, the aqueous suspension containing the core particles having the initial thin film on the surface thereof so as to perform electroless plating and so that grainless boundaries are recognized in cross section in a

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direction of a thickness of the nickel film as claimed in
independent claim 3.

Applicants respectfully submit that Experiment 2, which relates to the method of Kawakami et al., in one of the Declarations under 37 CFR 1.132 filed on October 26, 2007, clearly proves that an initial thin film is not formed on the surface of the core powder by using the method described in Kawakami et al. because the reducing agent contained in the aged plating solution does not have a high reducing power sufficient to reduce metal ions. Therefore, Kawakami et al. do not teach, disclose or suggest the claimed steps (II) and (III) of the present invention.

In the office action, the Examiner believed that the Declaration under 37 CFR 1.132 filed on October 26, 2007 was insufficient to overcome the rejection based on Kawakami et al. because the Experiments described in the Declaration omitted claimed step (III). The Examiner also believed that the claimed step (III) was obvious over Kawakami et al. Also, the Examiner believed that Kawakami et al. taught that a fresh nickel ion-containing solution, a complexing agent solution and a solution of a reducing agent were added to the aged plating solution

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containing a dispersed core particles (see page 6, lines 1-3 of the office action).

Accordingly, applicants respectfully submit that Experiment 1 of the Declaration under 37 CFR 1.132 filed with this amendment discloses an additional experiment was prepared with added claimed step (III) using the aqueous suspension containing the core powder obtained from Experiment 2, which relates to the method of Kawakami et al., in one of the Declarations filed on October 26, 2007.

It is clear from the result of Experiment 1 and Fig. 1 of the Declaration that the method described in Kawakami et al. would not have been obvious to perform electroless plating for forming grainless boundaries of the nickel film on the surface of the core particles as claimed in the present invention since grainless boundaries were formed. As discussed above, the present invention includes the unexpected results by providing a nickel film having grainless boundaries as shown in Fig. 1 of the present invention where the adhesion between the nickel film and the surface of the core particle is remarkably high.

Specifically, the concentration of sodium hypophosphite in the wastewater of electroless plating after use in Experiment 1, which relates to the method of Kawakami et al., in one of the

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Declarations filed on October 26, 2007 was measured with a following analysis method.

1) The wastewater of electroless plating was added to a triangle flask with stopper using 2 ml whole pipette.

2) 20 ml of 6 mol hydrochloric acid solution was measured in a graduated cylinder, and it was added.

3) 0.05 mol iodine standard solution was added using a 20 ml whole pipette.

4) It was corked, and was shaken, and put it in a dark place for 30 minutes.

5) The amount of sodium hypophosphite was estimated by titration using 0.05 mol sodium thiosulfate standard solution.

6) 3 to 5 ml of starch indicator as an indicator was added. After these processes, the concentration of the sodium hypophosphite was calculated as follows: the concentration of the sodium hypophosphorous acid (g/L) = [(the number of the titration of an empty experiment (ml)) - (the number of the titration of this experiment (ml)) x 2.65 x dilution magnification x F] (F: 0.05 mol - factor of sodium thiosulfate standard solution).

The result of the concentration of sodium hypophosphite in the wastewater of electroless plating after use in Experiment 1, which relates to the method of Kawakami et al., in one of the

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Declarations filed on October 26, 2007 was less than 0.01 g/L. By the result of this experiment, it proves that sodium hypophosphite in the wastewater of electroless plating after use in Experiment 1, which relates to the method of Kawakami et al., in one of the Declarations filed on October 26, 2007 has a weak reducing property and it does not have a reducing property sufficient to reduce metal ions. Therefore, an electroless plating reaction was not carried out by the method described in Kawakami et al. Moreover, even though the claimed step (III) using the aqueous suspension containing the core powder obtained from Experiment 2, which relates to the method of Kawakami et al., in one of the Declarations filed on October 26, 2007 was processed, it did not perform electroless plating forming grainless boundaries of the nickel film on the surface of the core particles as claimed in the present invention in part because an initial thin film was not formed on the surface of the core powder by using the method described in Kawakami et al.

For these reasons, it is believed that Kawakami et al. do not show or suggest the present claimed features of the present invention. Applicants also submit that Weber et al. do not make up for the deficiencies in Kawakami et al.

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Weber et al. relate to a substrate, a method of nucleation, a powder, and a method for metal plating (see column 1, lines 6-7). Glass substrates in the form of plates of glass or glass powder were nucleated with palladium and then coated with a layer of nickel/tungsten (see column 3, lines 49-52).

Weber et al. also disclose that in addition to the Ni/W alloy, layers including alloys such as Ni/Sn, Co/W and Co/Mo, a single metal such as Ni, Cu, Ag, Au and platinum metals or metal oxide can be applied (see column 5, line 45-48).

Weber et al. do not disclose the steps of (II) dispersing the core particles in an aqueous medium comprising an initial thin-film-forming solution containing nickel ions, a reducing agent, and a complexing agent comprising an organic carboxylic acid or a salt thereof to prepare an aqueous suspension, and reducing the nickel ions to form a nickel initial thin film on the surface of the core particles; and (III) adding a first solution, which contains a nickel ion-containing solution and the complexing agent, and a second solution, which contains a reducing agent-containing solution, to the aqueous suspension individually and simultaneously, the aqueous suspension containing the core particles having the initial thin film on the surface thereof so as to perform electroless plating and so that

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grainless boundaries are recognized in cross section in a direction of a thickness of the nickel film as claimed in independent claim 3 (emphasis added).

In the office action, the Examiner disagreed with applicants' arguments regarding when the Weber et al. process was applied to the core particles using several different conditions, no continuous Ni metal coating was obtained. However, applicants respectfully submit that in fact, one of the Declarations filed on October 26, 2007, which relates to the method of Weber et al., proves that when the Weber et al. process is applied to the core particles using several different conditions, no continuous Ni metal coating was obtained. The reasons why continuous Ni metal coating was not carried out in the electroless plated bath of Weber et al. are discussed below.

Applicants respectfully submit that Experiment 2 of the Declaration filed with this amendment proves that even though the nickel ion-containing solution and the reducing agent-containing solution were individually and simultaneously added to the aqueous suspension of Weber et al., a nickel metal was not deposited on the surface of the core particles. By the result of this experiment, applicants respectfully submit that an initial thin nickel film was not formed on the surface of the core powder

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based on the method described in Weber et al. and therefore, the electroless plating reaction was not carried out on a low activity place which does not have initial thin film.

Also, applicants respectfully submit that electroless plating reaction in Weber et al. was not carried out because Gluconic acid is strongly chelated with Ni and W under a pH 9. In addition, applicants respectfully submit that electroless plating reaction in Weber et al. was not carried out because Ammonia works complexing agent under around pH 9 so that no continuous Ni metal coating was obtained. Further, no grainless boundaries were found in the experiment using the Weber et al. process.

Also, applicants respectfully submit that Weber et al., Kawakami et al. and none of the prior art references do not teach, suggest and disclose the steps of (II) dispersing the core particles in an aqueous medium comprising an initial thin-film-forming solution containing nickel ions, a reducing agent, and a complexing agent comprising an organic carboxylic acid or a salt thereof to prepare an aqueous suspension, and reducing the nickel ions to form a nickel initial thin film on the surface of the core particles; and (III) adding a first solution, which contains a nickel ion-containing solution and the complexing agent, and a

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second solution, which contains a reducing agent-containing solution, to the aqueous suspension individually and simultaneously, the aqueous suspension containing the core particles having the initial thin film on the surface thereof so as to perform electroless plating and so that grainless boundaries are recognized in cross section in a direction of a thickness of the nickel film as claimed in independent claim 3 (emphasis added).

The present invention and Declarations show that the grainless boundaries provide unexpected results. To achieve these, the initial thin film is formed on the surface of the core particles in a process of the claimed step (II) by using an initial thin film forming solution. Then, the same kind of complexing agent used in the claimed step (II) is contained in the first solution in a process of the claimed step (III) for growing the film including grainless boundaries on the surface of the core particles.

Applicants respectfully submit that both Kawakami et al. and Weber et al. do not teach, suggest or disclose the claimed steps (II) such that the initial thin nickel film is formed on a surface of each of the core particles. Even though the Examiner believed that the claimed step (III) was obvious over Kawakami et

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al., applicants respectfully submit that none of the references teach, suggest or disclose using the claimed aqueous suspension containing the core particles provided with the initial thin nickel films. Therefore, it would not have been obvious to form grainless boundaries of a nickel film based on the method described in Kawakami et al. and Weber et al.

For these reasons, it is believed that Weber et al. do not show or suggest the present claimed features of the present invention. Applicants also submit that Segawa et al. do not make up for the deficiencies in Kawakami et al. and Weber et al.

Segawa et al. relate to apparatus for electroless plating and method for forming conductive film.

Segawa et al. disclose an apparatus for an electroless plating capable of suppressing a change of a plating liquid with time and carrying out electroless plating homogeneously and accurately, and provide a method for forming a conductive film (abstract).

Segawa et al. do not disclose the steps of (II) dispersing the core particles in an aqueous medium comprising an initial thin-film-forming solution containing nickel ions, a reducing agent, and a complexing agent comprising an organic carboxylic acid or a salt thereof to prepare an aqueous suspension, and

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reducing the nickel ions to form a nickel initial thin film on the surface of the core particles; and (III) adding a first solution, which contains a nickel ion-containing solution and the complexing agent, and a second solution, which contains a reducing agent-containing solution, to the aqueous suspension individually and simultaneously, the aqueous suspension containing the core particles having the initial thin film on the surface thereof so as to perform electroless plating and so that grainless boundaries are recognized in cross section in a direction of a thickness of the nickel film as claimed in independent claim 3.

It is therefore respectfully submitted that Kawakami et al., Weber et al., and Segawa et al., individually or in combination, do not teach, disclose or suggest the presently claimed invention and it would not have been obvious to one of ordinary skill in the art to combine these references to render the present claims obvious.

New independent claim 20 has been added in the application. Applicants respectfully submit that new independent claim 20 is similar to claim 1 and also recites "(II) dispersing the core particles in an aqueous medium comprising an initial thin-film-forming solution containing 1) nickel ions, 2) a reducing agent

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including one of sodium hypophosphite, sodium borohydride, potassium borohydride, dimethylamine borane, hydrazine and formalin, and 3) a complexing agent comprising an organic carboxylic acid or a salt thereof to prepare an aqueous suspension, and wherein said step of dispersing the core particles in the aqueous medium includes adjusting the reducing agent in the initial thin film-forming solution in the range between 4×10^{-4} and 2.0 mol/l so that the nickel ions are reduced to form initial thin nickel film on a surface of each of the core particles". Applicants respectfully submit that these claimed features of new independent claim 20 are different from Kawakami et al, Weber et al., Segawa et al. or any combination of these references.

The present invention discloses that examples of reducing agents which may be used include sodium hypophosphite, sodium borohydride, potassium borohydride, dimethylamine borane, hydrazine, and formalin (see page 12, lines 13-15 of the specification). Also, the present invention discloses that the concentration of the reducing agent in the initial thin film-forming solution is preferably 4×10^{-4} to 2.0 mol/l and more preferably 2.0×10^{-3} and 0.2 mol/l (see page 14, lines 9-13 of the specification).

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Specifically, the minimum concentration of sodium hypophosphite is calculated as follows: the minimum concentration of the sodium hypophosphite (g/L) = 4×10^{-4} [mol/l] x 105.99 (Molecular Weight of the sodium hypophosphite). The result of the minimum concentration of sodium hypophosphite is 0.042 (g/L).

Also, the minimum concentration of sodium borohydride is calculated as follows: the minimum concentration of the sodium borohydride (g/L) = 4×10^{-4} [mol/l] x 37.83 (Molecular Weight of the sodium borohydride). The result of the minimum concentration of the sodium borohydride is 0.015 (g/L).

Also, the minimum concentration of potassium borohydride is calculated as follows: the minimum concentration of the potassium borohydride (g/L) = 4×10^{-4} [mol/l] x 53.94 (Molecular Weight of the potassium borohydride). The result of the minimum concentration of the potassium borohydride is 0.022 (g/L).

Also, the minimum concentration of dimethylamine borane is calculated as follows: the minimum concentration of the dimethylamine borane (g/L) = 4×10^{-4} [mol/l] x 58.92 (Molecular Weight of the dimethylamine borane). The result of the minimum concentration of the dimethylamine borane is 0.024 (g/L).

Also, the minimum concentration of hydrazine is calculated as follows: the minimum concentration of the hydrazine (g/L) = 4

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$\times 10^{-4}$ [mol/l] \times 32.05 (Molecular Weight of the hydrazine). The result of the minimum concentration of the hydrazine is 0.013 (g/L).

Also, the minimum concentration of formalin is calculated as follows: the minimum concentration of the formalin (g/L) = 4×10^{-4} [mol/l] \times 30.03 (Molecular Weight of the formalin). The result of the minimum concentration of the formalin is 0.012 (g/L).

On the other hand, as described above (see pages 14-16 of this amendment), the result of the concentration of sodium hypophosphite in the wastewater of electroless plating after use in Experiment 1 of the Declaration filed on October 26, 2007 was less than 0.01 g/L. By the result of this experiment, it proves that sodium hypophosphite in the wastewater of electroless plating after use in Experiment 1 of the Declaration filed on October 26, 2007 has a weak reducing property and it does not have a reducing property sufficient to reduce metal ions. Therefore, the nickel ions were not reduced to form an initial thin nickel film on the surface of each of the core particles by the wastewater. Also, none of the other prior art references show this feature.

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Applicants respectfully submit that it is critical to adjust the reducing agent in the initial thin film-forming solution to a range where the nickel ions are reduced to form initial thin nickel film on a surface of each of the core particles. This critical concentration range has been included in new claim 20. Therefore, allowance of new independent claim 20 is also respectfully requested.

Also, new dependent claim 21, which depends from new independent claim 20, has been added in the application. Applicants respectfully submit that new dependent claim 21 recites the step of "dispersing the core particles in the aqueous medium includes adjusting the reducing agent in the initial thin film-forming solution in the range between 2.0×10^{-3} and 0.2 mol/l". Applicants respectfully submit that this additional feature of new dependent claim 21 also defines over the prior art of record.

Specifically, the minimum concentration of sodium hypophosphite is calculated as follows: the minimum concentration of the sodium hypophosphite (g/L) = 2.0×10^{-3} [mol/l] x 105.99 (Molecular Weight of the sodium hypophosphite). The result of the minimum concentration of sodium hypophosphite is 0.21 (g/L).

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Also, the minimum concentration of sodium borohydride is calculated as follows: the minimum concentration of the sodium borohydride (g/L) = 2.0×10^{-3} [mol/l] x 37.83 (Molecular Weight of the sodium borohydride). The result of the minimum concentration of the sodium borohydride is 0.075 (g/L).

Also, the minimum concentration of potassium borohydride is calculated as follows: the minimum concentration of the potassium borohydride (g/L) = 2.0×10^{-3} [mol/l] x 53.94 (Molecular Weight of the potassium borohydride). The result of the minimum concentration of the potassium borohydride is 0.11 (g/L).

Also, the minimum concentration of dimethylamine borane is calculated as follows: the minimum concentration of the dimethylamine borane (g/L) = 2.0×10^{-3} [mol/l] x 58.92 (Molecular Weight of the dimethylamine borane). The result of the minimum concentration of the dimethylamine borane is 0.12 (g/L).

Also, the minimum concentration of hydrazine is calculated as follows: the minimum concentration of the hydrazine (g/L) = 2.0×10^{-3} [mol/l] x 32.05 (Molecular Weight of the hydrazine). The result of the minimum concentration of the hydrazine is 0.064 (g/L).

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Also, the minimum concentration of formalin is calculated as follows: the minimum concentration of the formalin (g/L) = 2.0×10^{-3} [mol/l] x 30.03 (Molecular Weight of the formalin). The result of the minimum concentration of the formalin is 0.06 (g/L).

Applicants respectfully submit that the narrower range set forth in claim 21 is also critical for forming the initial thin nickel film on the surface of each of the core particles. Therefore, allowance of new dependent claim 21 is also respectfully requested.

Also, new dependent claim 22, which depends from new independent claim 20, has been added in the application. Applicants respectfully submit that new dependent claim 22 recites the step of "(IV) forming a gold plating layer as a top layer on the nickel film". Applicants respectfully submit that this additional feature of new dependent claim 22 also defines over the prior art of record. Therefore, allowance of new dependent claim 22 is also respectfully requested.


In view of foregoing claim amendments and remarks, it is respectfully submitted that the application is in condition for allowance and an action to this effect is respectfully requested.

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If there are any questions or concerns regarding the amendments or these remarks, the Examiner is requested to telephone the undersigned at the telephone number listed below.

Respectfully submitted,

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